

# Gamma-ray White Papers from Astro2010

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# Astro2010 White Papers - basics

- Deadline: Feb. 15, 2009
- Types:
  - Science (341 WPs submitted)
  - State of the profession (69 WPs submitted)
  - Technology development (66 WPs submitted)
  - Theoretical, Computation, and Laboratory Astrophysics (8 WPs submitted)
- 7 page limit for science
- 10 page limit for other types

# Astro2010 Call for Science White Papers

- Categories for science WPs mirror the 5 Science Frontier Panels (SFPs)
  - Planetary Systems and Star Formation (PSF)
  - Stars and Stellar Evolution Panel (SSE)
  - The Galactic Neighborhood Panel (GAN)
  - Galaxies Across Cosmic Time Panel (GCT)
  - Cosmology and Fundamental Physics Panel (CFP)
- Many WPs are in more than one category/SFP

# Astro2010 Call for Science White Papers

- WP call included the “Charge to the Panels”
  - Identify new scientific opportunities
  - Describe the scientific context
  - Describe the key advances needed
  - List up to 4 central questions that are ripe for answering
    - Plus a Discovery Area (added later)
- WP call included advice: “Focus on the Science”
  - WPs will be of most use to the SFPs if they identify directly specific critical questions and opportunities as well as the potential measurements and/or theoretical advances that will address them.

# Results for the Panel on Electromagnetic Observations from Space (EOS)

TABLE 6.2 The Questions Posed by the Astro2010 Science Frontiers Panels, Correlated with the Activities Recommended by the EOS Panel

Science Frontiers Panel Question/Discovery Area	WFIRST	IXO	EXO-PLANET	BLISS SPICA	UV-Optical Telescope
PSF-1 How do stars form?					Dark Blue
PSF-2 How do circumstellar disks evolve and form planetary systems?	Light Red		Dark Green	Dark Purple	Light Blue
PSF-3 How diverse are planetary systems?	Dark Red		Dark Green		Dark Red
PSF-4 Do habitable worlds exist around other stars, and can we identify the telltale signs of life on an exoplanet?	Light Red		Dark Green		Dark Red
PSF-D Identification and characterization of nearby habitable exoplanets			Dark Green		Dark Red
SSE-1 How do rotation and magnetic fields affect stars?		Orange			
SSE-2 What are the progenitors of Type Ia supernovae and how do they explode?	Light Red	Light Orange			
SSE-3 How do the lives of massive stars end?		Orange			Dark Blue
SSE-4 What controls the mass, radius, and spin of compact stellar remnants?	Light Red	Orange			
SSE-D Time-domain surveys	Dark Red				

- Message for GammaSIG: We need to get our questions on these lists

TABLE 6.2 Continued

Science Frontiers Panel Question/Discovery Area	WFIRST	IXO	EXO-PLANET	BLISS SPICA	UV-Optical Telescope
GAN-1 What are the flows of matter and energy in the circumgalactic medium?		Orange			Dark Blue
GAN-2 What controls the mass-energy-chemical cycles within galaxies?		Orange		Dark Purple	Dark Blue
GAN-3 What is the fossil record of galaxy assembly from the first stars to the present?	Light Red	Light Orange		Light Purple	Dark Blue
GAN-4 What are the connections between dark and luminous matter?	Dark Red	Orange			Dark Blue
GAN-D1 Time-domain astronomy	Dark Red				Light Blue
GAN-D2 Astrometry	Light Red		Light Green		Dark Blue
GCT-1 How do cosmic structures form and evolve?	Dark Red	Orange		Dark Purple	Dark Blue
GCT-2 How do baryons cycle in and out of galaxies, and what do they do while they are there?	Light Red	Orange			Dark Blue
GCT-3 How do black holes grow, radiate, and influence their surroundings?	Light Red	Orange	Light Green	Dark Purple	Light Blue
GCT-4 What were the first objects to light up the universe, and when did they do it?	Light Red	Orange		Dark Purple	Light Blue
GCT-D The epoch of reionization					
CFP-1 How did the universe begin?					Dark Blue
CFP-2 Why is the universe accelerating?	Dark Red	Light Orange			Dark Blue
CFP-3 What is dark matter?	Light Red		Light Green		Light Blue
CFP-4 What are the properties of neutrinos?	Dark Red	Light Orange			
CFP-D Gravitational wave astronomy					

NOTE: Darker color indicates a strong impact of the facility on answering the question. "Exoplanet" entries correlate the PSF questions with several proposed missions, as described in the panel report text. The maroon squares under "UV-optical telescope" refer to a possible planet-finding and characterization capability.

# Results for the Panel on Particle Astrophysics and Gravitation (just showing 2 SFPs)

TABLE 8.8 Continued

Science Question	Missions						
	LISA	Pulsar Timing Array	Lunar Laser Ranging	AGIS/CTA	HAWC	ULDB	Auger N
<b>Stars and Stellar Evolution</b>							
SSE 1: How do rotation and magnetic fields affect stars?	—	—	—	Gamma rays from stars, binary systems, supernova remnants...	Gamma rays from stars, binary systems, supernova remnants...	—	Ultrahigh-energy cosmic-ray probe of galactic magnetic field relevant for star formation
SSE 2: What are the progenitors of Type Ia supernovae?	White-dwarf/white-dwarf binaries in galaxy, which can be progenitors of Type Ia supernovae	Provides pulsar survey	—	—	—	—	—
SSE 3: How do the lives of massive stars end?	Black holes from the first generation of stars	Provides millisecond pulsar survey	—	Gamma rays from gamma-ray bursts (GRBs), supernova remnants	Gamma rays from GRBs, supernova remnants	—	Cosmic rays and neutrinos from GRBs
SSE 4: What controls the mass, radius, and spin of compact stellar remnants?	>10 <sup>4</sup> compact binaries in the galaxy	Requires discrete sources	—	—	—	—	—
Discovery area: Time-domain surveys	Binary black hole mergers and extreme mass ratio inspirals	—	—	—	Gamma-ray transients	—	—

TABLE 8.8 Continued

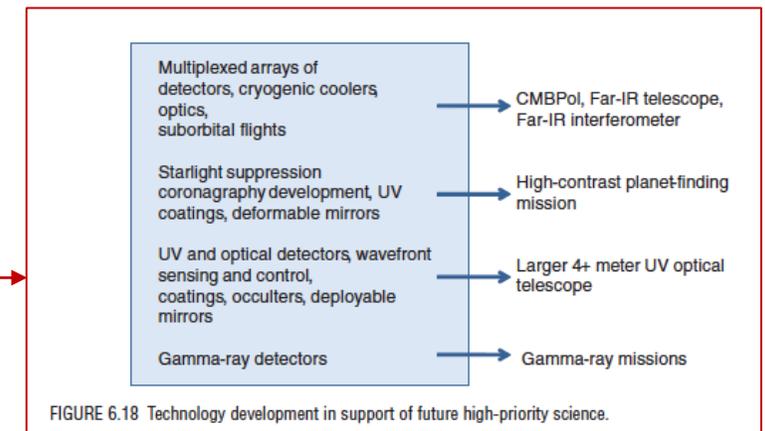
Science Question	Missions						
	LISA	Pulsar Timing Array	Lunar Laser Ranging	AGIS/CTA	HAWC	ULDB	Auger N
<b>Cosmology and Fundamental Physics</b>							
CFP 1: How did the universe begin?	Gravitational waves are direct probe of early universe	Gravitational waves are direct probe of early universe	Tests of general relativity	—	—	—	—
CFP 2: Why is the universe accelerating?	Strong, direct tests of general relativity from gravitational wave sources	Gravitational wave background model dependent	Tests of general relativity	—	—	—	—
CFP 3: What is dark matter?	—	—	—	Indirect dark matter searches (gamma rays from dark matter halo)	Indirect dark matter searches (gamma rays from dark matter halo)	Indirect dark matter searches (positrons, anti-nuclei, ...)	—
CFP 4: What are the properties of neutrinos?	—	—	—	—	—	Greisen-Zatsepin-Kuzmin (GZK) ultrahigh-energy neutrinos	Ultrahigh-energy GZK cosmic rays and neutrinos
Discovery area: Gravitational wave astronomy	Open low-frequency window—very rich in astrophysical sources	Open very-low-frequency window—possibly best chance to detect cosmological background	—	—	—	—	—

NOTE: Shaded entry, direct connection to science question. Unshaded entry, indirect or possible connection but not guaranteed.

- Gamma-rays did pretty well in the SSE and CFP panels
- Not shown, but also GRBs/AGN/blazars in GAN and GCT panels

# Proposed Program of Activities – Astro2010

- Large Space Projects
  - WFIRST
  - Explorer Program Augmentation
  - LISA
  - IXO
  - (EXIST and SIM were not included in the recommended program)
- Medium Space Projects
  - New Worlds Technology Program (prep. for a planet-imaging mission)
  - Inflation Probe Technology Program (CMB polarization)
- Small Space and Ground Projects (11 listed)
  - E.g., A&A Research Grants/NSF, ATP/NASA, Lab. Astro/NASA
  - U.S. contribution to SPICA (if e-ASTROGAM had been selected)
  - Intermediate Technology Development
  - Suborbital program



# Astro2010 White Papers

- White papers available at [http://sites.nationalacademies.org/bpa/bpa\\_050603](http://sites.nationalacademies.org/bpa/bpa_050603) and <http://www8.nationalacademies.org/astro2010/publicview.aspx>
- Examples relevant to GammaSIG (quickly found a dozen or so)
  - Hunter et al., “Medium Energy Gamma-Ray Astrophysics”
  - EXIST-related
    - Gridlay et al., “Measuring the Accreting Stellar and IMBH Populations...”
    - Hartmann et al., “Tracing the Cosmic Star Formation History to its Beginning [w/ GRBs]”
    - Coppi et al., “Lifting the Veil on the BH-Galaxy Connection”
  - Leising et al., “Nuclear Gamma-Ray Astrophysics”
  - Diehl et al., “Astrophysics with Radioactive Atomic Nuclei”
  - McConnell et al., “X-ray and Gamma-ray Polarimetry”
  - Wulf et al., “Semiconductor Compton Imager and Polarimeter (SCIP)” - Technology

# Backup

- I left some of the slides (slightly edited) from the WP list we made around the time of the HEAD meeting.
- I could imagine the discussion leading into these
- However, the information in the following slides might be better for a separate presentation (or just to put up when we are dividing up into groups)

# List of Probe class projects (hard X-ray to gamma-ray)

- **Transient Astrophysics Probe (TAP) – J. Camp, J. Racusin**
- **Spectroscopic Time-Resolving Observatory for Broadband Energy X-rays (STROBE-X) – P. Ray**
- **All-sky Medium Energy Gamma-ray Observatory (AMEGO) – J. McEnery**
- **X-ray Polarimetry Probe (XPP) – H. Krawczynski**
- **The High-Energy X-ray Probe (HEX-P) – F. Harrison**

# List of WPs relevant to GammaSIG

- Radionuclide Astronomy – Chris Fryer
- Dark Matter in the MeV regime – Regina Caputo
- GRB Polarimetry – Mark McConnell
- Lunar Occultation Technique and LOX – Richard Miller

# List of WPs relevant to GammaSIG

- MeV Science with Compton Cameras
  - SMILE, ETCC (Hamaguchi), COSI (Boggs/Tomsick), AMEGO and e-ASTROGAM (McEney)
- Particle Acceleration
  - E.g., Colliding Wind Binaries (Kenji Hamaguchi)
- Science enabled with high energy resolution at hard X-rays
  - SCOTTI (Fabian Kislak) goes from 0.5-100 keV, but because of XARM, this WP might need to be based on the 10-100 keV science ( $^{44}\text{Ti}$ , CRSFs)
- Science enabled with optical/IR measurements of prompt GRB emission
  - Need GRB positions at the few arcmin level for rapid ( $\sim 10$  seconds) repointing with a multi-band optical/IR instrument (Bruce Grossan)
- Inverse Compton in Star-Forming Galaxies (HEAD presentation by Tonia Venters)
- U.S. Participation in e-ASTROGAM (with Alessandro de Angelis)
- Synergies between TeV (HAWC/SGSO/CTA) and MeV/GeV (Fermi/AMEGO)
  - Possible involvement from P. Huentemeyer, G. Vianello, T. Weisgarber, D. Williams

# List of WPs relevant to GammaSIG

- AGN (Eileen Meyer, Filippo D'Ammando, Rani Bindu expressed interest, but unclear whether they have the same science focus and whether this is a single or several WPs)
- Type Ia SNe and All-Sky MeV (Richard Miller)
- Flare stars (Lisa Winter)